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Co-variability of Cloud and Precipitation over Land and Ocean

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◆ Science questions that motivate us

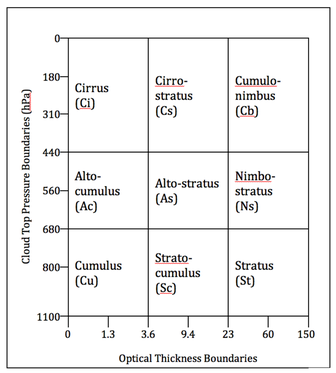
- **How well do certain precipitation rates relate to certain cloud types?**
- **What are the limits in predicting precipitation given a cloud type?**
- **Do answers to the above differ substantially between oceans and continents?**

◆ Data

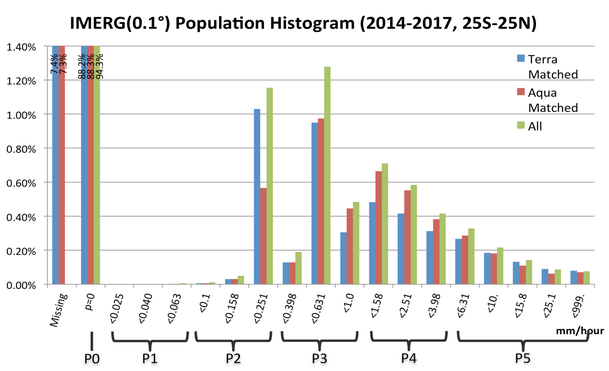
- **Cloud:**
  - MODIS C6 daily, 1°×1°, Terra and Aqua data, 25°S–25°N (Tropics)
  - 2D Joint histogram of Cloud Optical Thickness (COT) and Cloud Top Pressure (CTP)
- **Precipitation:**
  - Integrated Multi-satellitE Retrievals for GPM (IMERG; ½-hourly, 0.1°×0.1°, 2014.04-2017.02)

◆ Methodology

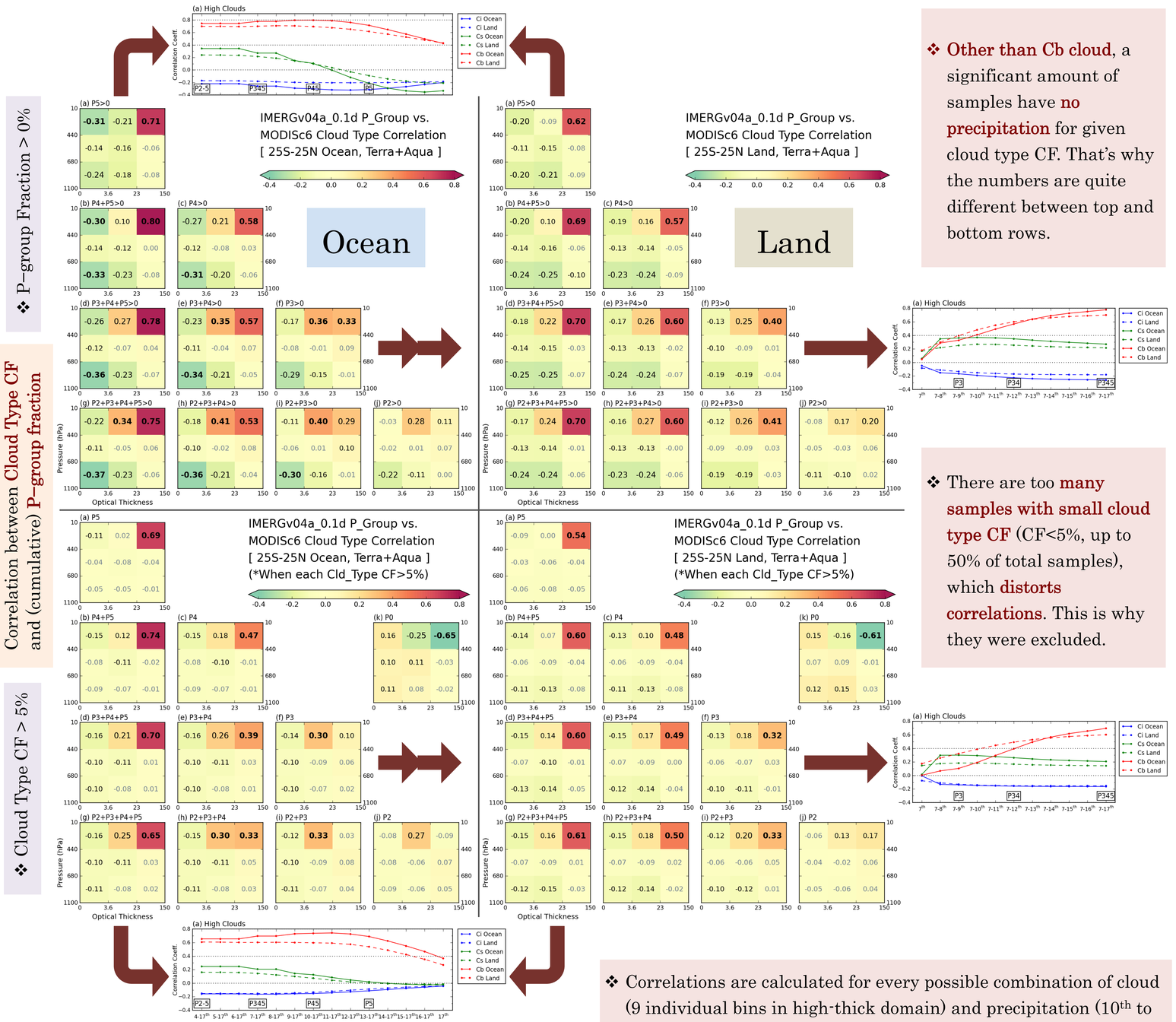
- **Temporal Match:**
  - Calculate UTC of Terra and Aqua overpass, and assign to appropriate IMERG ½-hour interval
- **Spatial Match:**
  - Collect 100 (=10×10) IMERG values for each MODIS 1° gridcell and transform to ***histogram***
- **Simplification**
  - 42 bins of MODIS joint histogram are grouped into 9 (ISCCP) cloud types
  - 18 bins of precipitation histogram are grouped into 6 P-groups (5 with P>0)
- **Correlation calculation**
  - Coefficient from spatio-temporal co-variations between cloud type CF and P-group fraction



↑ ISCCP cloud types assigned to MODIS joint histogram of COT-CTP



↑ Precipitation histogram using pre-defined bin boundaries (log scale) and definition of P-group



❖ Other than Cb cloud, a significant amount of samples have no precipitation for given cloud type CF. That's why the numbers are quite different between top and bottom rows.

❖ There are too many samples with small cloud type CF (CF<5%, up to 50% of total samples), which distorts correlations. This is why they were excluded.

❖ Correlations are calculated for every possible combination of cloud (9 individual bins in high-thick domain) and precipitation (10th to 17th bin comprising P4 and P5), and best 5 sets are shown here.

Summary and Conclusion

❖ For both land and ocean, **heavy precipitation is best related to Cb** clouds, as expected.

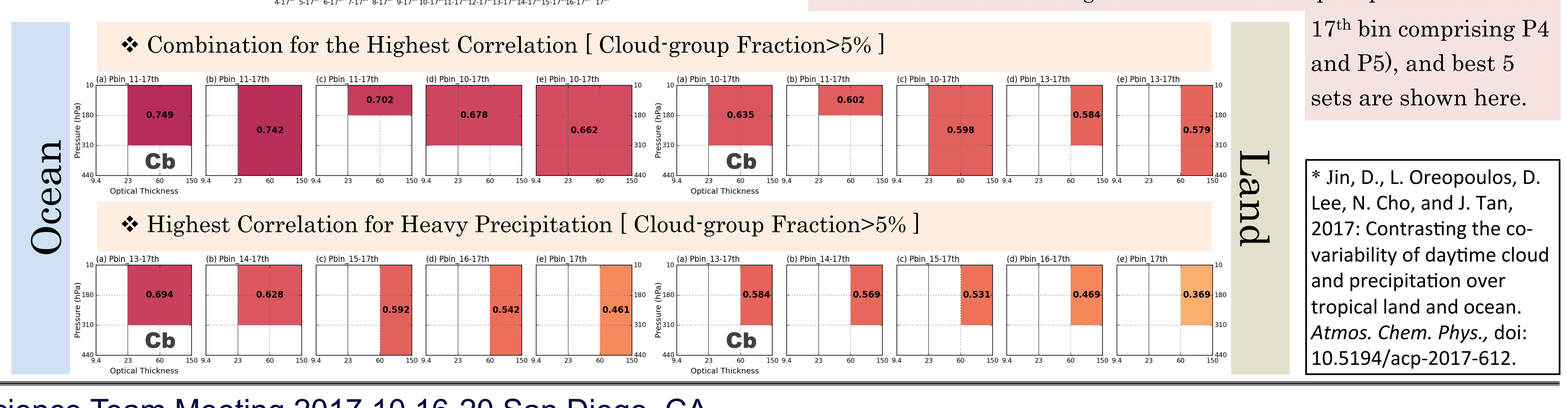
❖ Other cloud types associate with large variability of precipitation.

❖ **Over Land**, **Cb clouds** co-occur with a **broader range of precipitation**.

❖ When **heavy precipitation** occurs, it is **anticorrelated to Cu** cloud.
- Actually this is because Cb and Cu CFs are anticorrelated (not shown)

❖ The **highest correlations** are seen with the **coarse** cloud and precipitation bins.
- Extreme precipitation has lower correlation with clouds.
- Maybe due to uncertainty coming from 1 deg grid scale

❖ Overall results are consistent with Jin et al. (2017)* using TMPA.



* Jin, D., L. Oreopoulos, D. Lee, N. Cho, and J. Tan, 2017: Contrasting the co-variability of daytime cloud and precipitation over tropical land and ocean. *Atmos. Chem. Phys.*, doi: 10.5194/acp-2017-612.